

REMARKS

Claims 1-14 are pending upon entry of amendments. Claim 15 is cancelled without prejudice. Favorable reconsideration in light of the amendments and the remarks which follow is respectfully requested.

I. The Amendments

Support for the amendments to claim 1 can be found throughout the specification as filed. Support for amended claim 1, for example, can be found at paragraph [0033], wherein the first polymer is described as a polydiene, and at paragraph [00039], wherein the second polymer is described as a living polymer having an anionic reactive group. Support can also be found in the claims as originally filed.

II. Claim Objections

Claims 1-15 stand objected to incorrect capitalization of “epoxidizing” in claim 1 and similar capitalization in claim 15. The capitalization in claim 1 is corrected by amendment and claim 15 is cancelled. Therefore, the objection is moot.

III. Rejection of Claims 4 and 8 Under 35 U.S.C. § 112, Second Paragraph

Claims 4 and 8 stand rejected under 35 U.S.C. § 112, second paragraph, for not complying with distinct claiming requirements. Claim 1 is amended such that both claims 1 and 4 refer to the reactive group in the singular form. Claim 1 is further amended to recite “anionic charge” such that the term “the anionic charge” in claim 8 has proper antecedent bases. Therefore, the rejection is moot.

IV. Rejection of Claims 1, 2, 6-11, and 14 Under 35 U.S.C. § 102(b)

Claims 1, 2, 6-11 and 14 stand rejected under 35 U.S.C. § 102(b) over Knauss (U.S. 6,255,424).

Independent claim 1 recites, *inter alia*, a “the second polymer is a living polymer and the at least one reactive group is an anionic reactive group” for reacting with the epoxide group of the first polymer. The first polymer is an epoxidized polydiene. Knauss contains no description of polymerization proceeding through an epoxide functionality as recited in claim 1.

As shown in Figure 3 of Knauss, Knauss is directed toward reaction of one polystyrene-based polymer having a reactive carbanion stabilized by Li^+ (PS^-Li^+) with a second polystyrene-based polymer having a group pendent on the benzene ring of second polymer susceptible to nucleophilic attack, such as the depicted chloromethyl group (haloalkane). That is, the formation of a branched polymer in Knauss proceeds by nucleophilic attack of a carbanion of one polymer on a haloalkane functionality of a second polymer.

Knauss describes polymers capable of first, non-branching polymerization through a linking second polymer having a “first group [that] is a vinyl group capable of undergoing an addition polymerization reaction.” Knauss, col. 3, ln. 44-45. Branching occurs through a “second group [that] is a different group and the second group being a substituent pendant from the benzene ring of the styrene group, a preferred second group for the coupling agent includes a moiety capable of being nucleophilically displaced to effect the desired coupling, such as a halo group.” Knauss, col. 3, ln. 46-55. That is Knauss clearly describes polymerization through a polystyrene precursor “having an anionic living end” (col. 10, ln. 64) with a coupling agent (second polymer) having a “moiety capable of being nucleophilically displaced,” where the only example of a moiety capable of being nucleophilically displaced is a halo group on an alkane substituent of a benzene ring.

Knauss contains no description of branching polymerization occurring through a reactive epoxide group, as recited in claim 1. The Examiner refers to Knauss col. 16, lines 45-55 as allegedly teaching polymerization through an epoxide group. The paragraph cited by the examiner refers to **termination reactions**, where after “a dendritic structure of the present invention has grown to a desired molecular weight . . . the polymer may be **terminated by a**

terminating reaction at the focal point.” Knauss, col. 16, ln. 35-38. Such a termination is suggested to be made by “an epoxide functionality . . . formed by the addition of an excess of epichlorohydrin.” Knauss, col. 16, ln. 51-53. That is, the epoxide described in the cited section is to **terminate and stop polymerization**. The epoxide does not go on to react and propagate a polymer as recited in claim 1. Since Knauss does not describe polymerization proceeding through an epoxide functionality, the rejection should be withdrawn.

Further, the polymer systems described by Knauss do not have the advantageous features of the claimed polymer system. The method described in Knauss can only lead to the introduction of a single functional group located at the focal (central) point of the molecule. Reaction of this single functional group cannot yield generation-based growth of the type observed for arborescent polymers by repetitions of grafting reactions. In the specific case where a dendritic structure with a single epoxide group would be used as a grafting substrate, it could either lead to a hybrid structure (e.g. by coupling a “living” linear polymer chain with the epoxide-functionalized polymer), or to a dimerized structure (e.g. by coupling with a “living” dendritic structure, carrying an anionic reactive site at the focal point). In both cases, the reaction could not be carried on to provide further increases in branching functionality. This is not the case in the reactions described in the current application, since multiple epoxide functionalities are introduced on the substrate at each step of the reaction, and lead to rapid increases in branching functionality over successive generations (grafting reactions). This growth mechanism, whereby the molecules grow from the inside out (new material added always forms an additional layer outside the molecules), is known as divergent growth. In contrast, the different generations obtained in Knauss are produced simultaneously by combination of smaller dendritic fragments into larger (higher generation) structures. This growth mechanism is known as convergent growth, since it always takes place by a reaction involving the focal point of the molecule, located at the center. Molecular growth thus takes place from the outside (periphery of the molecules) to the center. Knauss therefore fails to disclose the method for producing the

arborescent polymers defined by the amended claims and, as such, fails to anticipate the claimed invention.

Therefore, it is respectfully requested that the rejection of claims 1, 2, 6-11 and 14 under 35 U.S.C. § 102(b) be withdrawn.

V. Rejection of Claims 15 Under 35 U.S.C. § 102(b)

Claim 15 stands rejected under 35 U.S.C. § 102(b) over Knauss (U.S. 6,255,424). Claim 15 is cancelled; therefore, the rejection is moot.

VI. Rejection of Claims 1-5 and 13 Under 35 U.S.C. § 102(b)

Claims 1-5 and 14 stand rejected under 35 U.S.C. § 102(b) over Yamamoto et al (JP 2002-105209).

In order for a novelty rejection to be proper, one item cited by the examiner must disclose each and every claim feature. Yamamoto et al fails to disclose “the second polymer includes at least one reactive group capable of forming bonds with the epoxide groups [of the first polymer], and wherein the second polymer is a living polymer and the at least one reactive group is anionic reactive group,” as recited in claim 1.

Yamamoto et al discloses the use of hydroxyl anions to open the epoxide rings on a substrate molecule. “An epoxidized polydiene is reacted with polyether having a hydroxyl group, or . . . a polyol/a polyether-polyol.” Yamamoto et al, Abstract. Claim 1 requires the epoxide group of the first polymer to be reacted with a second polymer that is a “living polymer” having an anionic reactive group. The hydroxyl reactive groups described by Yamamoto et al are not anionic, but are rather charge-neutral amphiphiles. The disclosed process therefore relies on the presence of –OH groups on the polymer to be grafted as side chains. The reactions are limited to poly(alkylene oxide) side chains, and the method could not be used to graft vinyl and diene “living” polymers carrying an anionic propagating centre as used in the claimed method. Because of the inability of the method described in Yamamoto et al to generate graft polymers with polydiene side chains, the grafting procedure cannot be

repeated to obtain a dendritic architecture. The architecture of a graft polymer produced by the method disclosed in Yamamoto et al is limited to the synthesis of a G0 arborescent polymer.

Therefore, it is respectfully requested that the rejection of claims 1-5 and 14 under 35 U.S.C. § 102(b) be withdrawn.

VII. Rejection of Claim 12 Under 35 U.S.C. § 103(a)

Claim 12 stand rejected under 35 U.S.C. § 103(a) over Knauss and Huyskens et al (J. Molecular Liquids).

Dependent claim 12 incorporates all of the features of claim 1. As discussed above, Knauss contains no disclosure regarding propagation of polymerization through reaction of an epoxide with an anionic living polymer. Huyskens et al appears to only relate to the polymerization of polystyrene lithium (PStLi) in tetrahydropyran, which does not proceed through an epoxide moiety. Therefore, no combination of Knauss and Huyskens et al reaches the features of the claim. The rejection should be withdrawn for at least this reason.

Further LiCl taught in Huyskens et al is not equivalent to the alkyl lithium taught in Knauss. As shown in Figure 3 of Knauss, the alkyl lithium (sec-butyl lithium in the Examples, col. 17) is a very strong base (carbanion) that extracts a proton from a polymer to form an anionic living end. Sec-butyl lithium is the conjugate base of sec-butane; sec-butane has an estimated pKa of >25 and possibly >30. Frederick G. Bordwell, Acc. Chem. Res.; **1988**; 21(12) pp. 456 - 463 (reporting pKa of similar alkane carbon acids). In contrast, Cl⁻ ion of LiCl has no basic properties whatsoever and does not have a conjugate acid. Other additives mentioned in Huyskens et al, such as Tert-BuOLi, are bases. However, the conjugate acid of tert-BuOLi is tert-butanol, which has a pKa of only 18. E. P. Serjeant and B. Dempsey (eds.), *Ionization Constants of Organic Acids in Solution*, IUPAC Chemical Data Series No. 23, Pergamon Press, Oxford, UK, 1979; http://chemweb.unp.ac.za/chemistry/Physical_Data/pKa_values.htm. That is, sec-butyl lithium is a base about 10 orders of magnitude stronger than tert-BuOLi.

The system of the Knauss relies upon the use of a very strong acid (alkyl halide) to abstract an alkane hydrogen from a polymer to form a negative charge. The system of Huyskens et al does not require initiation through use of a strong base. Huyskens et al only discusses polymerization of polystyryl lithium, which only requires Li^+ to dissociate to form PSt^- , which is then polymerized. That is, the system of Huyskens et al does not require an external base to be added. Huyskens et al, p. 152 and equations describing k_1 . Further, Huyskens et al does not teach that LiCl initiates and/or even increases the rate of polymerization of PSt^- generated from polystyryl lithium. As shown in Table 1, k_1/k_1° , is the rate of polymerization in the presence of LiCl (k_1) divided by the rate of polymerization without LiCl (k_1°). For concentrations of polystyryl lithium less than about 10^{-2} M, **the polymerization is slower** with k_1/k_1° less than 1. "[A] marked reduction of k_1 which sometimes drops below 30% of its value in the absence of additive" is observed. Huyskens et al, paragraph bridging pp. 154-55. Further, the fact that k_1° is a non-zero number indicates that LiCl or any other additive is not needed to initiate polymerization, and LiCl is never described as a promoter or an initiator of any kind in Huyskens et al.

Huyskens et al discusses non-classical effects caused by the presence of certain additives and a mathematical treatment thereof. In particular, the non-classical effects are a result of the Li ion being present in an anion (ClLiCl^-) or a cation (LiClLi^+), since "the concentrations of the triple ions are not ruled by the classical mass action law." Huyskens et al, page. 151. "The participation of the Li^+ in this reversible process competes with its specific interaction with the electron donor site of the solvent to give LiSt^+ [LiSt^- associated with a triple cation]," whose polymerization is impaired. *Id.* at 151 & 176. Huyskens et al goes on to discuss how a classical treatment cannot explain the experimentally observed kinetics due to the generation of PStLiClLi species. *Id.* at 176. LiCl, Tert-BuOLi, etc. are explored as different sources of Li and complex ions.

Therefore, it is respectfully requested that the rejection of claim 12 under 35 U.S.C. § 103(a) be withdrawn.

VIII. Petition for Extension of Time

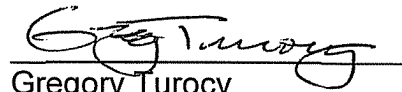
A request for a three-month extension of time is hereby made. Small entity status has been established. Payment is made *via* the EFS filing system.

In the event any fees are due in connection with this document, the Commissioner is authorized to charge those fees to Deposit Account No. 50-1063.

Should the Examiner believe a telephone interview would be helpful to expedite favorable prosecution, the Examiner is invited to contact applicant's undersigned representative at the telephone number listed below.

Respectfully submitted,

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